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Cruising for parking: New empirical evidence and influential factors on cruising time

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Abstract: The goal of this study is to explore the perceptions and behaviors of drivers who cruise for parking. We conducted surveys with drivers in Brisbane, Australia, to understand potential factors that influence drivers' cruising behavior. This study reveals that errors in drivers' perception of parking cost are one of the leading factors encouraging drivers to cruise for on-street parking. Drivers are not necessarily well informed about parking costs, even when they claim to be familiar with these costs. The survey also reveals that the more informed drivers are about the local traffic and parking conditions, the less likely they are to cruise for extended periods of time. This finding demonstrates the value of traffic and parking information to effectively mitigate cruising for parking. The interview results also demonstrate that the on-street parking premium (i.e., accessibility or convenience factor) could be much larger than our common assumptions and a significant contributor to increased cruising time. Finally, this study introduces the sunk cruising cost and its potential impact on cruising time. Our hypothesis is that the effect of the sunk cost may manifest in a greater tendency for drivers to continue cruising because the time spent cruising is simply unrecoverable past expenditure. The survey data supports our hypothesis, and with findings on the drivers' misperception about parking cost and the familiarity factor, this result highlights the value of accurate and timely parking cost and availability of information to drivers to tackle the cruising-for-parking issue.

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1 Introduction

The economics of parking and associated driver behavior has recently attracted increased research attention in recognizing parking policies as an effective management option to ease travel demand. Recent studies highlight the "cruising for parking" phenomenon as a common and natural behavior of drivers who search for more affordable and convenient on-street parking. Cruising for parking causes addition-

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al, and potentially significant traffic delays in peak hours by adding an extra burden to already congested roadways. Past studies report that cruising traffic may account for up to 30percent (Allen, 1993), or even almost half of the peak hour traffic (Arnott & Rowse, 1999) in urban downtown districts.

Cruising for parking can increases where different opportunities are accessible to drivers whether to park on the street or in parking lots. This choice between on-street parking and off-street parking has been studied extensively (Qian, Xiao, & Zhang, 2012; Arnott & Rowse, 2013). On-street parking is generally less expensive than off-street parking; thus, attracts a much higher demand because of the higher price sensitivity of drivers. This additional demand appears to be exacerbated by the added accessibility factor, encouraging cruising for on-street parking. On the other hand, off-street parking is generally more expensive, but has better and more predictable availability—eliminating the need for waiting or cruising for parking. These relatively simple rules dictate individual driver decision-making. However, widespread cruising behavior has significant social costs that include increased traffic congestion and air pollution.

The aim of this study is to explore the perceptions and behaviors of drivers who cruise for on-street parking. We conducted intercept surveys with drivers to evaluate potential factors that influence their cruising behavior, in addition to the conventional parking price factor, to quantify their impact on cruising time. This paper presents additional variables that contribute to better explaining cruising behavior. The research adds to the body of knowledge in multiple ways, with a primary focus to provide new empirical evidence for understanding cruising behavior. van Ommeren, Wentink, and Rietveld (2012) argue that the parking research literature lacks empirical data in analyzing cruising behavior. We agree with this position and address this knowledge gap with the survey data from our study. Data from parking options with differential fares (within the same timeframe) in Brisbane, Australia, is applied to evaluate reliable price sensitivity analysis of drivers. This study quantifies the value of on-street parking premium based on the interview data. The survey input from users on perceived cost of on- and off-street parking provides a comparative analysis between actual and perceived parking costs. The last component of the research is comprised of longitudinal interview data over the period when parking fees increased significantly. The purpose of this is to investigate the long-term price sensitivity of drivers and confirm theories of driver price sensitivity.

2 On-street or off-street parking?

Cruising for parking is essentially an economic decision. Much of the literature reviewed discusses the cost of parking as the dominant determinant of the cruising behavior (Glazer & Niskanen, 1992; Arnott & Inci, 2006; Shoup, 2006; Inci & Lindsey, 2015). The basic principle behind this theory is that, ultimately, the equilibrium will be reached when the price difference between on- and off-street parking is negated by the cruising costs incurred by individual drivers. In other words, cruising may be eliminated when the cost of on-street parking is set equal to the cost of off-street parking. Some assumptions appear to be widely adopted including: i) all drivers have the perfect knowledge of parking price and availability and; ii) all drivers make economically rational decision to minimize parking and associated cruising costs.

Earlier studies in this domain attempted to derive optimal pricing schemes of parking to manage peak-hour traffic and congestion through economic parking models. Arnott, de Palma, and Lindsey (1991) suggested a location-dependent pricing to prevent queuing for parking and to reduce schedule delay costs of travelers. This model was further enhanced to incorporate the stochastic availability of vacant parking spaces (Arnott & Rowse, 1999). Glazer and Niskanen (1992) associated the cost of parking and traffic congestion through an assumed relationship between the parking fee and the period of parking. They argued that increasing a parking fee induces shorter parking periods and quicker turnovers

of the parking spaces, which eventually brings in more traffic and congestion to the area. Box (2000) discussed the potential congestion and accident effects of street parking. Although the study did not identify cruising for parking as the main causes of congestion, it emphasized the role of off-street parking to address the issue of the street parking congestion. The author also proposed that the convenience and walking distance as the primary factor encouraging drivers to search for street parking.

On-street parking offers a premium of accessibility such as convenience and short walk to destination. However, the accessibility factor has been largely unexplored in the literature. Only one study by Kobus, Gutierrez-i-Puigarnau, Reitveld, and van Ommeren (2013) provides an approximated value of the on-street parking premium derived from their empirical study, which was estimated to range from €0.37 to €0.60 in the Netherlands. The authors suggest that the demand for on-street parking is price elastic when the parking duration is longer than one hour, so even a small reduction in the on-street parking price could induce a strong increase in the parking demand.

Cathrop (2002) considered the effects of on-street parking pricing on other distorted transport markets including off-street parking. Later, Cathrop and Proost (2006) proposed an optimal on-street parking policy in the presence of an off-street parking availability. This study suggested that the on-street parking price should match that of off-street parking to prevent excessive cruising for street parking or excessive off-street investment costs. Anderson and de Palma (2004) attempted to include the collateral impacts of cruising for parking in their formulation for the optimal on-street parking price. This model assumes that cruising drivers induce additional delays to the subsequent parkers and normal traffic. The extra delay is modelled as a simple linear function in which the total delay increases by increasing number of cruising drivers. The study demonstrates that the benefit of parking pricing in terms of the social cost could be significantly diminished by cruising drivers.

The cruising for parking phenomena has emerged as a more central issue over the last decade. Shoup (2006) presented a comprehensive review of the past studies on cruising for parking which approximated the proportion of cruising vehicles between 8 and 74 percent of the total traffic, and the average cruising time between 3.5 and 14 minutes. The author argued that underpriced on-street parking is a mismanagement of scarce urban land, and the price of on-street parking must be set at least equal to that of off-street parking to eliminate cruising behaviour. He also highlighted other complications that must be explored for a better understanding of cruising other than only the parking price.

Arnott and Inci (2006) presented an integrated model of street parking and traffic congestion, in which the demand for downtown trip was determined by the total cost of trip including the cost of travel time and on-street parking. In a subsequent paper of Arnott (2006), a new model is developed to formulate the spatial competition between street parking and parking garage. Later, Arnott and Rowse (2009) proposed an enhanced model to incorporate street parking, parking garage, and traffic congestion into their calculations. This study demonstrated through the model that the garage-parking fee exceeding the on-street parking fee would equalize the full prices of garage-parking and on-street parking due to increased cruising vehicles and their travel time. They later extended the model to account for heterogeneous individuals having different time values and parking durations and suggested that on-street parking time limits can be an effective countermeasure to eliminate cruising for parking (Arnott and Rowse, 2013).

Qian et al. (2012) incorporated dynamic traffic queuing and time-varying traffic patterns in their parking choice model. Their model considered two parking clusters: a central cluster and a peripheral cluster, which were assumed to have different parking capacities, parking fees and accessibilities to the destination. To obtain the optimal network performance, the study suggested that all travelers use the central parking when it offers an overwhelming accessibility, and if the peripheral cluster offers competitive accessibility, the parking fee must be adjusted to utilize the peripheral cluster earlier to shift travel

demand. This study also demonstrated that the total social cost and individual's travel cost could be effectively reduced by parking pricing.

van Ommeren et al. (2012) derived the number of cruising drivers and the distribution of cruising time from the Dutch National Travel Survey. The descriptive information showed that 30 percent of the drivers cruised for on-street parking, but a majority of drivers spent only 1 minute for cruising with the average cruising time of 36 seconds. The relatively insignificant cruising time was explained by the identical parking rate of on- and off-street parking in most Dutch municipalities. In addition, this study found that the cruising time increases with the total travel duration and the parking duration, and the cruising is more common among shopping and leisure drivers compared to work-related commuters.

The literature on cruising for parking is dominated by economic models. Empirical evidence of cruising for parking is scarce and only a few attempts are made to estimate the level of cruising traffic and their cruising time (Shoup, 2006). van Ommeren et al. (2012) is the only recent empirical study that estimated the amount of cruising vehicles using a nation-wide random sample of car trips. Although insightful, these results are difficult to generalize because this study was conducted in areas with equal on- and off-street parking fares. The decision to cruise may involve more influential factors than the price factor solely portray. Walking accessibility of parking, unpredictable cruising time, and imperfect information about nearby parking prices are important but relatively unexplored considerations in the literature. This phenomenon is better understood with empirical observations rather than theoretical models, and thus a more realistic explanation of drivers' decision-making process.

3 The survey

Brisbane is the third largest city in Australia and faces severe traffic congestion during peak hour times. The study area for the research is located at the Southbank district of city, which is near the city center and connected with a series of bridges. This district is Brisbane's cultural and recreational precinct and one of most popular tourist attractions. Cinemas, museums, conservatorium, convention and exhibition center, and many more attractions draw a considerable level of leisure and recreational trips. Recurring traffic congestion occurs in this area during the afternoon peak-hours because of visitors and commuting traffic.

The Southbank district is an ideal location to observe and analyze cruising behavior because the predominant purpose of trips to this area is for leisure and shopping. This eliminates the possible noise in the data induced by drivers with different purposes for their trips (van Ommeren et al., 2012). Cruising for parking is reportedly not a common behavior among all drivers, but occurs more frequently by shoppers and tourists whose trips are occasional and less predictable (Anderson & de Palma, 2004). Automobile commuters may use a contracted parking space because they cannot afford to cruise in a daily basis. Shoppers and tourists, on the other hand, have no reserved parking space and additionally their lack of information about traffic conditions and parking locations make the most desirable parking spaces more competitive.

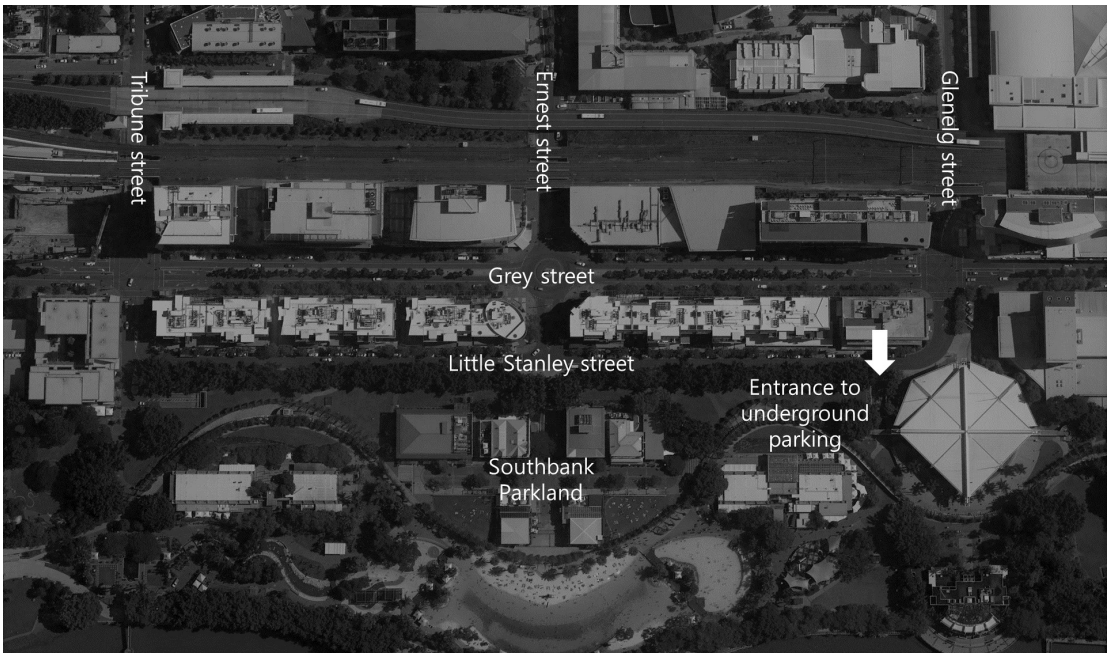

Figure 1: Southbank Study Area (source: Google Earth Pro)

The study area is illustrated in Figure 1. Approximately 100 on-street parking spaces are available along Grey Street and Little Stanley Street, lined with many popular restaurants and cafes. An underground parking plaza is available at the end of Little Stanley Street offering more than 800 spaces with lift and stair accessibility from its multiple entrances. The capacity of the underground parking is sufficient to accommodate the peak-hour demand at Southbank.

The data was collected in two separate intervals, May 17–June 15, 2013 and April 24–May 23, 2015. The 2013 survey asked respondents simply if they had cruised for on-street parking and duration of their cruising time. This survey is used mainly for comparison with the 2015 survey as the parking prices in the area have been changed significantly over the last two years especially for on-street parking. The more recent survey is the main data source for detailed discussions on cruising behavior.

The interviews were conducted in the early evening between 5 and 8 p.m. on Fridays and Saturdays when the area becomes busy with visitors. The face-to-face interviews were conducted along Grey Street and Little Stanley Street and around the entrance and exits of the underground parking plaza (Figure 1). The interviews were designed to take less than 10 minutes without demographic questions to increase the response rate as most interviews were conducted on the street. Drivers were randomly chosen, and requested to participate in a 5-minute interview to answer a number of questions about their parking experience. A screening question was asked to identify the driver of the car. A total of 100 drivers were interviewed for each survey, including 50 on-street parkers and 50 off-street parkers.

Some changes were made on the parking price structures between 2013 and 2015 (Table 1). On-street parking in 2013 was relatively inexpensive at only $2 per hour, whereas drivers had to pay $15 for entry to the parking plaza for up to three-hour stay. In 2013, for a three-hour stay, on-street parking cost only 40 percent of the off-street parking fee. The on-street parking price has been increased in 2015 to $4.40 per hour for weekdays, but unchanged for weekends, whereas the parking plaza fee is increased by $1. In 2015, for a three-hour visit, on-street parking fee is about 83 percent of the off-street parking fee for weekdays, and 38 percent for weekends.

Table 1: Parking Price Structure (evening rate) in Southbank, Brisbane

Year	Curb street parking	Underground parking
2013	$2.00 per hour up to three maximum hours (Mon–Sun)	$15.00 per entry up to three hours (Mon–Sun)
2015	$4.40 per hour up to three maximum hours (Mon–Fri) $2.00 per hour up to three maximum hours (Sat and Sun)	$16.00 per entry up to three hours (Mon–Sun)

The main survey (2015) consists of a total 11 questions to collect information from respondents about their experience and perceptions of cruising for parking. The main questionnaire was structured into five sections including: trip purpose and duration (Q1 & Q2); cruising time and associate behaviors (Q3, Q4 & Q5); parking choice and preference (Q6 & Q7); driver's knowledge of the local area and parking condition (Q8 & Q9); driver's knowledge of the parking price and price sensitivity (Q10 & Q11). The interview questions with processed responses are presented in Table 2.

Table 2: Main Survey (2015) Questions with Responses

Interview question	Response	
	On-street parkers	Off-street parkers
Q1. How long do you intend to stay? (multiple choice; 0-15 min; 16-30 min; 31-45 min; 46-60 min; 61-75 min; 76-90 min; 91-105 min; 106-120 min; Over 2 hrs)	105-120 min: 19%	105-120 min: 19%
	> 2hrs: 81%	> 2hrs: 81%
Q2. What is the main purpose of your visit to Southbank?	Business: 0%	Business: 0%
	Leisure: 100%	Leisure: 100%
	Others: 0%	Others: 0%
Q3. (for off-street parkers only), did you search for street parking first?		Yes: 100%
		No: 0%
Q4. How much time did you spend for cruising to search for on-street parking? (multiple choice: 0-2 min; 2-4 min; 4-6 min; 6-8 min; 8-10 min; 10-12 min; 12-14 min; 14-16 min; 16-18 min; 18-20 min; 20-22 min; 22-24 min; 24-26 min; 26-28 min; 28-30 min; over 30 min)	Avg: 13.38 min	Avg: 15.72 min
	StDev: 4.18 min	StDev: 3.23 min
Q5. Did you intend to spend such time for searching for parking	Yes: 26%	Yes: 20%
	No: 74%	No: 80%
Q6. Which parking do you prefer, underground or street parking?	On-street: 98%	On-street: 98%
	Off-street: 0%	Off-street: 0%
	No preference: 2%	No preference: 2%
Q7. What are the main factors affecting your preference?	Price: 90%	Price: 92%
	Accessibility: 8%	Accessibility: 6%
	Others: 2%	N/A: 2%
Q8. Are you familiar with the local area?	Yes: 90%	Yes: 94%
	No: 10%	No: 6%
Q9. Are you familiar with the traffic condition including the parking condition in Southbank at this time of day?	Yes: 86%	Yes: 86%
	No: 14%	No: 14%
Q10. How much do you expect to pay for parking for the duration of your stay?	Avg: $12.00	Avg: $20.60
	StDev: $3.33	StDev: $3.71
Q11. At what price difference between on-street and underground parking, would you use the underground parking as your first choice without searching for street parking?	Avg: -$1.34	Avg: -$2.96
	StDev: $1.69	StDev: $1.63

4 The analysis: Cruising for parking in Brisbane

To give an overview of the survey results; all the respondents visited Southbank for two hours or longer. They cruised for on-street parking for various time periods, and most of them preferred on-street parking (98 percent) because of the cheaper parking price (90percent percent of on-street parkers and 92 percent of off-street parkers). The survey results confirm that cruising for on-street parking is evident in Southbank. The reported average cruising time was 14.57 minutes (13.41 minutes for on-street parkers and 15.72 minutes for off-street parkers), which is significantly longer than those reported in previous studies (Shoup, 2006; van Ommeren et al., 2012).

All respondents reported that they cruised searching for on-street parking as their first choice. After 13 to 16 minutes of searching, some drivers managed to park on-street, while the others diverted to the underground parking plaza. On-street parking costs only a fraction of off-street parking in the study area, and provides direct pedestrian access to nearby attractions without stairs or ramps, while off-street parking is located in the underground parking plaza. Inexpensive parking fees and convenient accessibility appear to have encouraged drivers to cruise for on-street parking.

It is noteworthy that the reported cruising time of off-street parkers was longer than that of on-street parkers. Since the cost of off-street parking is more than on-street parking, according to the equilibrium theory proposed, the cruising time for off-street parkers should be less than that of on-street parkers. However, the cruising time of off-street parkers is more than on-street parkers, although they paid a higher fee for parking. This result is further discussed in the following sections.

4.1 Parking cost and availability information

A driver's knowledge of parking conditions is an important determinant of cruising behavior, and better-informed drivers choose to avoid cruising. A common theoretical assumption has been that drivers can make informed decision on parking choice, provided they know the costs structure and the parking conditions (Teng, Qi, & Yi, 2002). In a real-world setting, however, drivers are unlikely to possess the perfect knowledge of the parking cost and the prevailing parking conditions. The information of on-street parking availability is not readily available to drivers. Parking fees (especially off-street parking) fluctuate by location, time of day, day of week, and duration of stay, which facilitates substantial errors in assuming the actual parking cost for drivers.

The survey first assessed travelers' knowledge of the parking cost. The street parking rules and fees are relatively straightforward in the study area. Three parking zones are defined throughout the City of Brisbane where different rules and parking fees apply. On the other hand, the underground parking fee may vary between $12 and $22 for a three-hour parking depending on the time and day of visit. The survey examined if drivers have had the exact knowledge of the parking fee for the length of stay and potential impacts of misperceived parking cost on cruising for parking. The interview asked how long each respondent intended to stay in Southbank (Q1) and the expected parking cost for the period of stay (Q10). Figure 2 presents the comparison between expected versus actual parking costs.

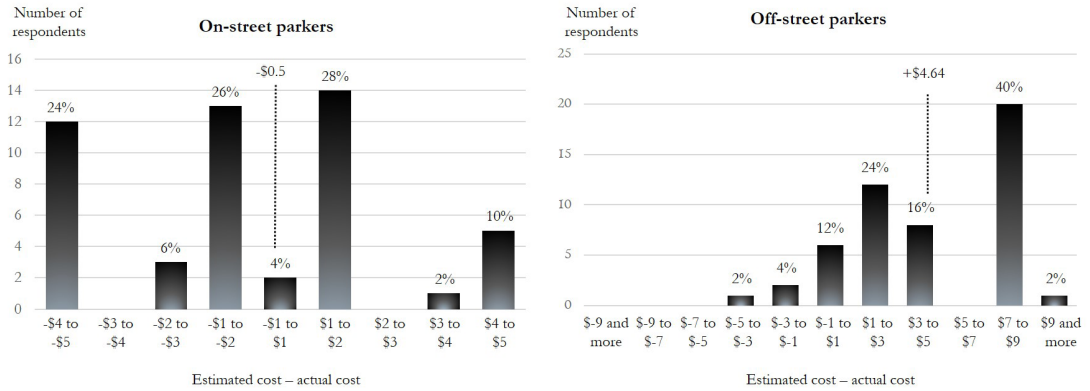

Figure 2: Expected vs. actual parking cost (for a three-hour parking duration)

The results demonstrate that predominant number of drivers misjudged the actual parking cost. Only 16 percent of total respondents had reasonably accurate knowledge of the parking cost with errors of less than $1. It is noteworthy that drivers slightly underestimated the on-street parking cost (-$0.5), whereas they significantly overestimated the underground parking fee, by $4.65 on average. A majority of on-street parkers (58 percent) estimated the parking cost relatively accurate with errors of less than $2.00. On the other hand, more than 40percent of off-street parkers overestimated the underground parking price by $7 or more. This is interesting because an overwhelming majority of respondents, both on- and off-street parkers reported that they were familiar with the local area (90 percent and 94 percent, respectively). Similarly, a significant majority (86 percent for both groups) also responded that they were familiar with the traffic and parking conditions of the area they were visiting. As combined with the former question; it is safe to assume that the travelers believed that they were knowledgeable on the logistics of parking and traffic conditions, but most of them had a significant error in their parking cost estimation.

Overestimated off-street parking may strengthen the perceived price competitiveness of on-street parking by drivers and encourage searching for street parking as a result. The difference between actual on- and off-street parking costs is $3.50 for a three-hour stay. This was exaggerated to $8.65 in the perception of drivers, which could have further inflated the competitiveness of on-street parking and the value of cruising. The significant majority of respondents (98 percent) preferred on-street parking as their first choice over off-street parking (Q6). Out of 98 respondents who preferred on-street parking, 91 of them picked the cheaper price of on-street parking as the primary reason, whereas 7 respondents chose the easy accessibility (Q7).

The errors in perceived parking cost may have been a result of the lack of information to visitors. The price of street parking is consistent across the entire parking zone and the survey verified that drivers had relatively accurate knowledge of the on-street parking cost. However, the underground parking fee varies largely depending on time of day, day of week, parking duration, and various promotions offered by the business operator. Perceived overestimation of the off-street parking cost will affect the decision-making of drivers to consider searching for more affordable parking. A worthwhile exercise to mitigate cruising may be facilitating a reliable dissemination measure to visitors to provide the parking cost information of adjacent parking plazas.

4.2 On-street parking premium

The convenience of on-street parking in accessing shops and restaurants around the area of interest is a significant determinant of parking behavior (Kobus et al., 2013). Another dimension of interest is the ease of exiting the parking facilities within the convenience factor, especially following larger crowd events—concerts, sports events etc. This accessibility factor is an important consideration for travelers in parking choice. The last question of the survey asked the respondents at what price difference would they use the underground parking as the first choice (Q11). Figure 3 illustrates the responses.

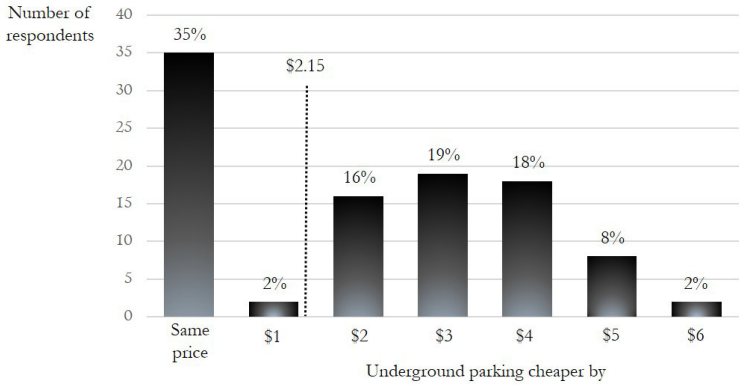

Figure 3: Willingness to pay extra for on-street parking

More than one-third of respondents (35 percent) answered that they would choose underground parking without cruising if the parking price is equal for on-street and underground parking. On the other hand, one tenth of respondents (10 percent) were willing to pay $5.00 or more per hour for the street parking premium and about the half of respondents (47 percent) answered that they would pay $3.00 or more per hour for the on-street parking premium. Overall, the on-street parking premium is estimated at $2.15 per hour—or $6.45 for a three-hour parking.

The survey results clearly demonstrate that drivers acknowledge the premium of on-street parking, and they are willing to pay additional price for the premium. For example, the street parking is currently $3.50 cheaper than the underground parking for a three-hour parking during weekdays in the study area. The implication to pricing policy is that the on-street parking fee may be increased by $9.95 ($3.50 + $2.15/hr times 3 hours) for a three-hour parking without reducing demand. Further increase of the on-street parking price than $9.95 will be effective to reduce the demand and cruising for on-street parking by negating the price competitiveness and premium of street parking.

4.3 Sunk cruising cost

We introduce the sunk cost effect to account for the unexpectedly long cruising times exhibited by the survey respondents. Sunk cost refers to the expenditure that has been made in the past and cannot be recovered by changing the decision (Arkes & Blumer, 1985). On-street parking becomes available to drivers in a manner of random reward rather than first-come-first-served. A newly arrived driver could overpass existing cruising drivers on any occasion and the time to find parking is uncertain and unpredictable. This nature of randomness could encourage drivers to test their luck with the support of overrated utility of street parking and underrated traffic and parking conditions. As the time spent

for cruising increases, the sunk cost increases as well because the investment (cruising time spent) for on-street parking is simply unrecoverable past expenditure by diverting to the underground parking. Drivers must consider the future costs and returns only and ignore their irreversible investment in the past to make economically rational decisions, but the effect of sunk cost may be manifested in a greater tendency to continue cruising because an investment has been made.

The hypothesis of sunk cruising cost appears to be supported by the survey responses (Q5). A larger percentage of drivers (77 percent) reported that they did not intend to cruise as much as they actually did. The average cruising time of this group was 16.1 minutes, whereas it was only 9.5 minutes for the other group of drivers (23 percent) who spend the cruising time as intended searching for on-street parking. An independent t-test verified that the mean cruising times between two groups are significantly different (p-value<0.01).

A possible explanation of this result is that the drivers in the latter group may have attempted to control their cruising time. They may have set a time on their cruising to avoid unremunerated search after a certain time. Some may have found a street parking under this constraint, but the others also have made the second-best decision to divert to the underground parking when their cruising time has reached or exceeded their time limit. Interestingly, the drivers in this group had more accurate knowledge of the parking cost ($0.43 and $2.90 for on-street and off-street parking, respectively compared to -$0.50 and $4.65). All of them also responded that they were familiar with the local area and the traffic and parking conditions. This may imply the value of information once more to mitigate cruising for on-street parking. The decision making of the drivers in the second group was based on more accurate knowledge of the parking and price information, which effectively reduced the vulnerability to the sunk cost effect and saved significant cruising costs as a result.

4.4 Impact of parking price increase

The last component of the data analysis is comparison of the reported cruising times between 2013 and 2015. Descriptive statistics of the 2013 survey are presented in Table 3 in comparison with the 2015 survey. The main difference in the two surveys is the year of survey (2013 & 2015) to capture the potential impact of parking cost escalations and the parking type (i.e., on-street and off-street). To test for the impact of parking type and year of survey, a 2-way ANOVA with no interaction was run (Table 4). The parking type effect was found insignificant, whereas the year of survey was found significant. The on-street parking fee (weekdays) increased substantially between 2013 and 2015. However, the desired effect of eliminating cruising was not observed, but the cruising time has further increased over the two-year period. The effect of pricing appears to have been diminished over time, or the rate of fee increase may have been insufficient to make a notable impact on parking choice and cruising behavior.

Table 3: 2013 and 2015 survey data

Year	Parking Location	Participants	Cruising time (min)	
			Average	St Dev
2013	On-street	70	13.32	6.17
	Off-street	70	12.78	5.73
2015	On-street	50	13.38	4.18
	Off-street	50	15.72	3.23

Table 4: ANOVA results

	Df	SSE	MSE	f-statistic	p-value
Time (Year)	1	135.60	135.63	5.06	0.03*
Parking type	6	169.70	28.28	1.06	0.39
Residuals	231	6189.90	26.80		

*Statistically significant at 0.05 level.

4.5 Factors influencing cruising time

A multiple linear regression analysis with 2015 survey data was conducted to numerically assess the effect of different influential factors on cruising time. Due to the lack of information about drivers' characteristics (i.e., socioeconomic standings), the objective of the modelling was to analyze the impact of selected factors on cruising time rather than present a generalized prediction model of the on-street cruising time. A stepwise method was used in developing the final regression model to predict *cruising time*—variables have been added to the model provided they improve the overall model fit and their coefficients are significant. The final variable included the predictors; *intend to cruise* (binary), *expected parking cost rate* (continuous), *on-street parking premium* (binary with the threshold value of $5), and *location and parking condition familiarity* (binary). The model was significant (F_{model}=33.01, p<0.01) with an R^2 value of 0.58. The details of each predictors' coefficients (unstandardized and standardized) and their significance are presented in Table 5.

Table 5: Cruising time model coefficients

Variable	Unstandardized Coefficient	Standardized Coefficient	t-statistic	p-value
Intercept	15.37	NA	14.98	.00*
Intend to Cruise	-6.16	-.67	-9.96	.00*
Expected Rate	.07	.10	1.38	.17
Premium	.37	.18	2.46	.02*
Familiarity	-1.59	-.15	-2.19	.03*

* Statistically significant at 0.05 level.

Of the four independent variables included in the analysis *intend to cruise* has the largest standardized coefficient as well as a negative impact on cruising time. When the drivers set a limitation in their searching time for on-street parking, their overall cruising time significantly reduces. Although unintuitive at first, this finding is consistent with the earlier discussions on the sunk cost of cruising. Drivers that have a time limitation to cruise also seem to better manage the sunk cost of cruising for parking; whereas drivers who do not have such a constraint appear to fail to properly assess their sunk costs objectively—in added cruising time.

The second independent variable is the *expected parking cost rate,* which has a positive relationship with cruising time. This is self-explanatory, as when the perceived cost of parking increases, so does the cruising time—perhaps due to the impression or the actual knowledge that on-street parking is cheaper than off-street parking and they could save more cost by searching for on-street parking. We demonstrated that drivers are unlikely to have perfect knowledge of the parking price information. The perceived parking cost can be expressed as the sum of the actual parking cost and the perception error. Therefore, cruising time can be reduced by controlling the errors in the perceived parking cost, especially overestimated off-street parking costs.

The third variable included in the model is the *on-street parking premium*, which is calculated for each driver based on their perceived cost values. We determined $5 as the threshold for significant perceived on-street parking premium. Drivers who reported on-street premium of $5 or more, increased their cruising time. This is also intuitive as the higher the cost of on-street parking premium, the more likely the drivers are to cruise for on-street parking. This result implies that the parking pricing must reflect the premium of on-street parking rather than simply equalizing the on-street and off-street parking prices to discourage cruising. To effectively discourage cruising behavior, on-street parking should be more expensive than off-street parking.

The last variable included in the model is the *location and parking condition familiarity*. The response to questions about familiarity with the location and its parking conditions are used to devise

this variable. If the participant answered yes to both questions, the variable included in the model was coded as 1, all other instances were recorded as 0. The reason for this variable was to capture the value of information in cruising decision-making. The more informed the drivers are about traffic and parking conditions, the less likely they are to cruise for extended periods of time, and the results here support this argument. Locational familiarity reduces the overall cruising time, and this can be attributed to better decision-making by drivers because of their prior knowledge.

5 Conclusion

This article presents the results of an empirical study aimed at better addressing the impact of driver perception of parking costs on traditional parking models and associated cruising for parking behavior. The article adds to the existing parking equilibrium models by identifying biases and inaccuracies in drivers' parking cost knowledge, and quantifying the cost of perceived on-street parking premium. We have argued that perceived costs are one of the major drivers of the cruising behavior and drivers are not well informed on parking costs, even when they claim to be familiar with these costs. We also have demonstrated that the on-street parking premium could be much larger than our common assumptions, and thus on-street and off-street parking are not even close to being perfect substitutes. Contrary to the earlier study by Kobus et al. (2013), we have found the premium to be $2.15 per hour on average and a significant contributor to the increased cruising time. Failing to reflect the premium factor in parking pricing will depreciate the effectiveness of pricing-based strategies to mitigate the cruising for parking.

Another contribution we make in this article is the introduction of sunk cruising costs together with the familiarity factor and their impact on cruising time. Our survey results indicate significantly higher cruising times than those of earlier empirical studies (Shoup, 2006). This is explained by the significantly different parking fees between on- and off-street parking in Brisbane. We are able to demonstrate that drivers who did not have a time limit in cruising time cannot make objective, economically viable decisions on when to stop cruising. Drivers who reported that they were familiar with the local traffic and parking condition spent less time for cruising. The findings on the drivers' familiarity (and its impact on cruising time) highlights the value of accurate and timely information of parking cost and parking conditions to drivers.

Lastly, we compare the price elasticity of drivers by comparing the data from the present study to an earlier survey in 2013. The results demonstrate that the cruising time for on-street parking is significant in both 2013 and 2015. Although the on-street parking price in weekdays has been significantly increased (from $2.00 to $4.40 per hour), it seems to have failed to reduce cruising behavior or the effect of pricing appears to have been diminished over time. This result further strengthens the findings of this study on developing a new pricing strategy to reflect the on-street parking premium and perceived parking costs and highlights the value of accurate and timely parking cost and availability information to drivers to tackle the cruising for parking issue.

The findings here are clear indicators of the need for additional empirical studies to reflect potential perception errors of drivers with regard to parking price and actual costs of cruising for on-street parking. In addition, further research is required for a comparison of "actual" and "perceived" cruising times. The data for this article is self-reported, and the reliability of these estimates should be confirmed with follow-up research. One challenge to study cruising for parking is that the exact cruising time may be difficult to define and varied by individuals. Finally, the number of on-street parking spaces in the study area is considerably small compared to the demand. The survey does not capture the drivers who gave up the trip either before starting or when they couldn't find a parking space. Although it is practically difficult to capture those drivers abandoned the trip during cruising for parking, including their time spent will increase the overall cruising time for parking.

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